POLARIZED LIGHT.

APPARATUS FOR EXHIBITING WIDE-ANGLED CRYSTALS.

BY GEO. M. HOPKINS.

IV.

The only simple device for exhibiting the rings and brushes of wide-angled crystals is the tourmaline tongs of the kind commonly employed by opticians for testing spectacle lenses; but the dark color of ordinary tourmaline renders a polariscope of this kind objectionable.

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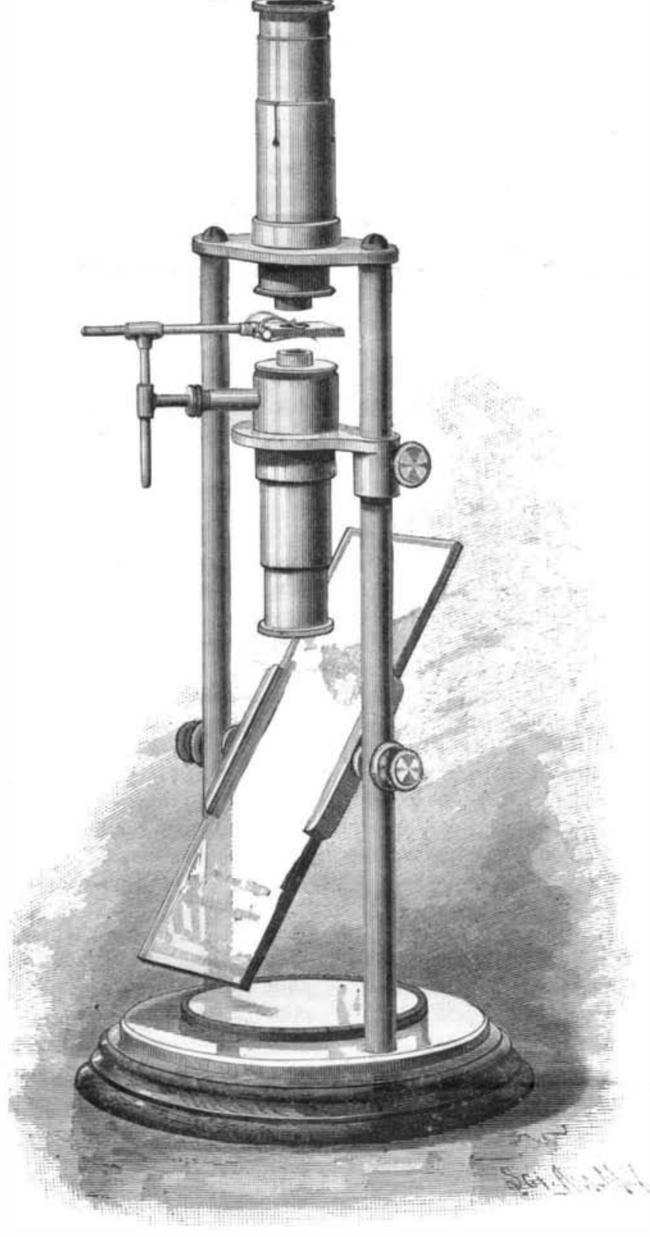

POLARISCOPE FOR EXHIBITING WIDE-ANGLED CRYSTALS.

A system of lenses devised by Norremberg, and improved by Hoffman, is at present employed for observing the phenomena of wide-angled crystals; but it is a matter of some difficulty to secure exactly such lenses as are required for the apparatus as constructed by Hoffman. Very good results, however, may be obtained by the employment of lenses designed for other purposes. Reference is made to the hemispherical condensing lenses used by microscopists, and ordinary meniscus (periscopic) spectacle lenses. Six lenses in all are required. The converging and collecting systems are exactly alike, but they are oppositely arranged with respect to each other. In the present case the two systems are adapted to a Norremberg doubler substantially like that described in the last article of this series, the main difference being that the instrument now illustrated is made principally of metal.

The tube of the upper system of lenses is prolonged upward beyond the upper lens to receive a Nicol prism, E, or other analyzer, which is mounted in a short inner tube arranged to revolve in the outer tube.

The lower system of lenses is contained by a tube fitted to the stage of the doubler. The arrangement of the lenses and analyzer is shown in Fig. 2. The two systems of lenses being alike, a description of one will answer for both. The object, A, to be observed is held between the adjacent ends of the two tubes in the universal holder shown in Fig. 1.

The lens, B, next the object is nearly a hemisphere, about eleven-sixteenths in. in diameter and three-eighths in. focus. The second lens, C, a meniscus (periscopic) spectacle lens of 3 in. focus, is arranged with the concave face one-sixteenth in. from the convex side of the hemisphere. Beyond the 3 in. meniscus, 3½ in. distant, is placed a bi-convex spectacle lens D, of 4 in. focus. The inner surfaces of the tubes are made dead black by the application of a varnish formed of lampblack, and alcohol in which only a trace of shellac has been dissolved.

The tubes may have any suitable diameter, and the proportions of the doubler may be about the same as indicated by Fig. 1, which is one-quarter actual size. The tubes and lenses shown in Fig. 2 are one-half size. The exact proportions, except as to the focal lengths and distances apart of the lenses, are immaterial. The lower system of lenses must produce a very convergent beam of light, while the upper system is arranged to collect the rays after they pass through the crystal, and bring them within the range of vision.

The angle between the optic axes in some crystals is so small as to permit of seeing them readily. Niter and carbonate of lead are examples of such crystals, but there are other crystals whose angle is so great as to render it exceedingly difficult to exhibit them, and in some crystals the angle is so wide as to render it impossible to see both axes at once. The only method of exhibiting them is by tilting the crystal first in one direction and then in the other, and viewing them separately.

Figs. 3 to 8 inclusive represent the figures shown by several crystals in the instrument illustrated. The drawings, having been made directly from the objects by the aid of the instrument, are correct in form and proportion, but the beautiful coloring is necessarily absent.

Fig. 3 shows the rings and brushes exhibited by calcite in a convergent beam of polarized light, with the polarizer and analyzer crossed. With the polarizer and analyzer parallel, the dark cross is replaced by a white one.

Niter is shown in Fig. 3 as it appears when the analyzer is crossed. With the analyzer parallel with the polarizing plate, the dark brushes are replaced by light ones. Turning the crystal in its own plane produces different effects.

In Fig. 5 is shown a figure produced by a slice of quartz cut at right angles to the axis of the crystal, and examined in the instrument with the analyzer arranged at an angle of 45° with the polarizer. Crystals of quartz vary in their effects on the polarized beam, some requiring the turning of the analyzer to the right, and others to the left to produce like results. For this reason the plates are called right or left handed, according to the direction in which the analyzer is required to be turned.

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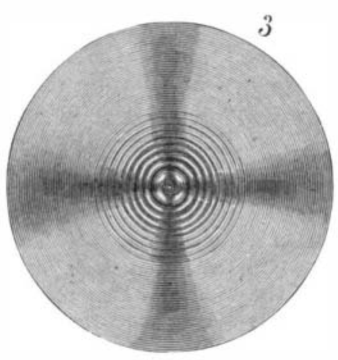

CALCITE.

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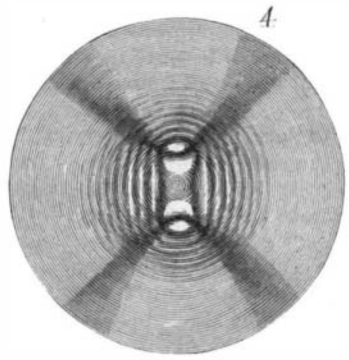

NITER.

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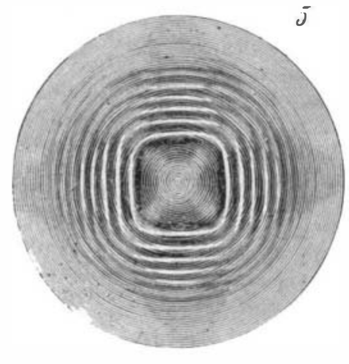

QUARTZ.

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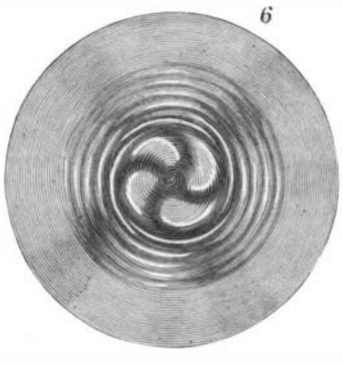

AIRY'S SPIRALS.

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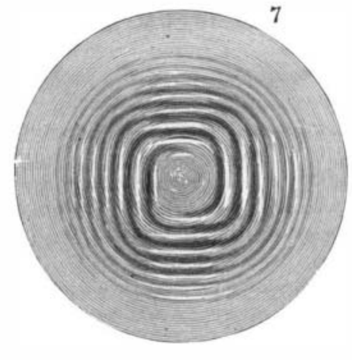

QUARTZ POLARIZED CIRCULARLY.

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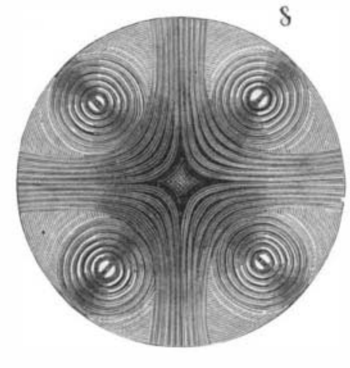

CALCITE HEMITROPE.

By superposing a right hand quartz on a left hand quartz, the beautiful spirals discovered by Airy, and named after their discoverer, may be exhibited. These spirals are shown in Fig. 6.

In Fig. 7 is shown the figure produced by the interposition of a quarter wave mica film between the polarizer and a plate of quartz viewed in the instrument. This altered appearance is due to circular polarization, a phenomenon readily understood on reading the literature of the subject, but requiring an explanation too elaborate for the space at command.

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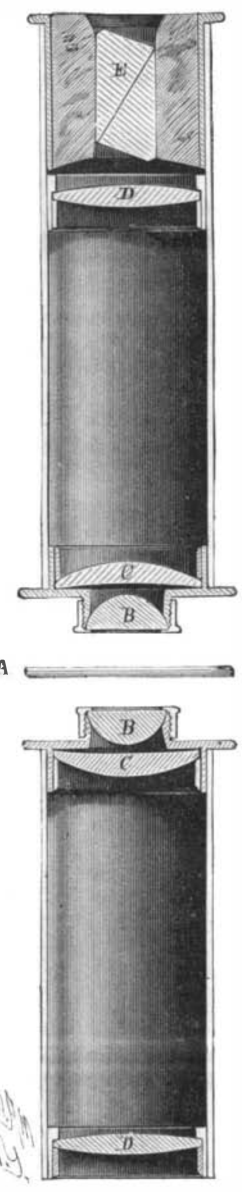

LONGITUDINAL SECTION OF TUBES OF POLARISCOPE.

Calcite polarized circularly shows singularly broken up and disjointed rings, the brush-like cross being absent; and when analyzed circularly, or viewed through a quarter wave plate, as well as through the analyzer, the rings appear perfect, and there are no transverse markings.

Fig. 8 shows the intricate figure produced by a calcite hemitrope, or pair of crystals arranged at right angles with each other. Somewhat similar figures are produced by crossed plates of mica.

The following is a list of some additional objects which may be viewed in the instrument: Sulphate of nickel, sugar, aragonite, bichromate of potash, chrysoberyl, chrysolite, topaz, anhydrite.

Instead of employing the Norremberg doubler for polarization, the lower tube may be prolonged, and a large Nicol prism inserted and arranged like the analyzer.

Boy Inventors.

There are a good many useful inventions which are the outcome of some boy genius, and the records of the Patent Office show that quite a number of patents have been issued to minors through their guardians. The invention of the valve to a steam engine is said to have been made by a mere boy. The story runs that Newcomen's engine was in a very incomplete condition, from the fact that there was no way to open and close the valve except by means of levers operated by hand. He set up a large engine at one of the mines, and a boy (Humphrey Potter) was hired to work these levers. Although this is not hard work, yet it required his constant attention. As he was working the levers he saw that parts of the engine moved in the right direction and at the same time he had to open and close the valves. He procured a strong cord, and made one end fast to the proper part of the engine, and the other end to the valve lever, and the boy had the satisfaction of seeing the engine move with perfect regularity of motion. A short time after the foreman came around, and saw the boy playing marbles at the door. Looking at the engine he saw the ingenuity of the boy, and also the advantage of his invention. The idea suggested by the boy's inventive genius was put in a practical form and made the steam engine an automatically working machine.

HYDRAULIC mortar.—1 of Portland cement, 2 of sand.